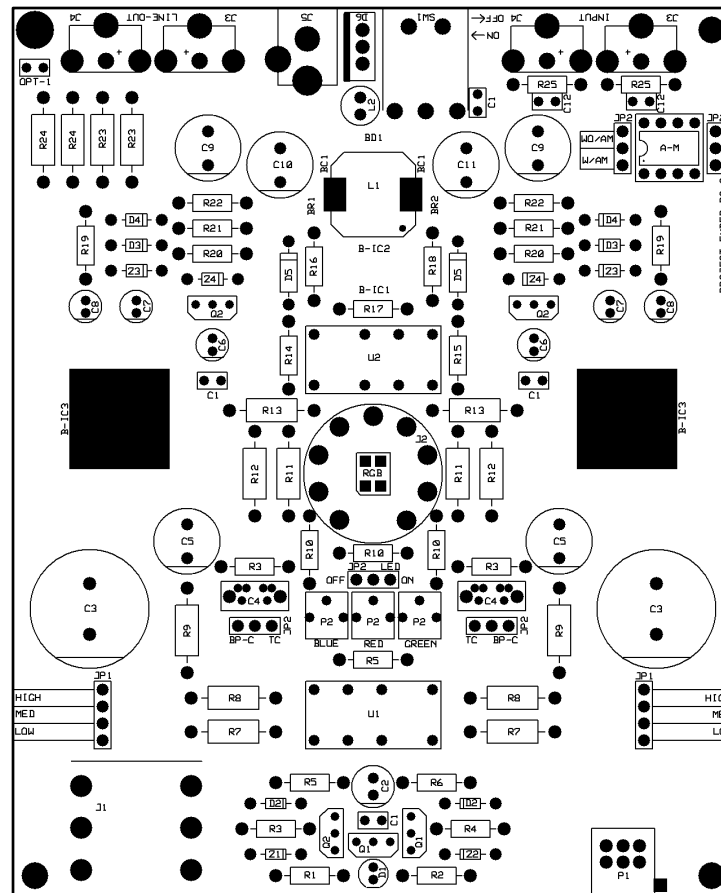


# Project Ember

VERSION II USER MANUAL – April 4<sup>th</sup> 2015

WWW.GARAGE1217.COM



## WARNING:

Although Project Ember runs at a generally safe 48VDC, Injury from improper assembly is quite possible. The main danger comes from installing the polarized capacitors backwards as they can only be installed in one direction much like a battery (more detail on capacitor installation comes later in this manual) If a capacitor is installed backwards, it may burst resulting in burns or eye injury. **If you are not experienced in electronics or electronic kit assembly, it would be wise to have an experienced electronics person review your work before powering the unit on.** Upon first power up, wear eye protection and be wary of any burning smells or electrical noises such as loud pops or buzzes

If using low impedance headphones with power ratings of 300mW or lower, there is a chance you could blow out the drivers if left playing at high levels – unattended. At high power levels an SPL of over 120dB may be reached in efficient headphones which is harmful to your hearing. Project Ember is a very high powered headphone amplifier – use caution and common sense. High output headphone amplifiers like Ember are designed to power very demanding headphones or provide all the headroom you could want with more efficient designs, not to see if you can get your jawbone to rattle.

**GARAGE1217.COM IS NOT RESPONSIBLE OR LIABLE FOR INJURY, PROPERTY LOSS OR DAMAGE AS THE RESULT OF ASSEMBLY OR USE OF THIS "DO IT YOURSELF" KIT. EMBER IS CONSIDERED A HOBBY LEVEL PRODUCT. IT CONTAINS NO ELECTRICAL CERTIFICATIONS AND IS NOT ADVERTISED AS SUCH. USE AT YOUR OWN RISK.**

# *Project Ember*

## Specifications

- Solid state output stage
- Non overall feedback - triode voltage gain stage
- Power consumption: 5W continuous, 15W peak
- Power supply: 48VDC (0.10A cont, 0.32A peak)
- Input Resistance: 11k $\Omega$  or 81k $\Omega$  depending on gain setting and module
- Input Sensitivity (6N23): 0.8V or 1.6V (dependent on gain setting and used tube)
- Gain: 14- 20dB (selectable and dependent on tube)
- Max Output voltage: 15.7Vrms at 300 $\Omega$
- Output Resistance: Selectable 0.1 $\Omega$ , 35 $\Omega$  or 120 $\Omega$
- Frequency Response: 3Hz – 65 KHz (-0.5dB) with 32 $\Omega$  load
- Frequency Response: 1.5Hz – 190 KHz (-3dB) with 32 $\Omega$  load
- Signal to Noise ratio: 92dBA (dependent on tube)
- Crosstalk: -89dB (dependent on tube)
- THD: > 0.010% (dependent on tube)
- Suitable for: 16-600 $\Omega$  Headphones, 32-600 $\Omega$  recommended

| OUTPUT<br>POWER<br>INTO: | OUTPUT RESISTANCE |       |       |
|--------------------------|-------------------|-------|-------|
|                          | .1R               | 35R   | 120R  |
| 16 $\Omega$              | 600mW             | 590mW | 180mW |
| 32 $\Omega$              | 1.4W              | 1.2W  | 290mW |
| 64 $\Omega$              | 2.4W              | 1.5W  | 450mW |
| 120 $\Omega$             | 1.8W              | 1.1W  | 480mW |
| 300 $\Omega$             | 765mW             | 600mW | 390mW |
| 600 $\Omega$             | 390mW             | 360mW | 270mW |

## Tubes / Valves that can be used in Project Ember

### 6V TUBES:

6922  
7308  
8223  
6AQ8  
6DJ8  
6GU7  
6CG7  
6BQ7A  
6H23  
6H23N  
6L12  
6N11  
6N23  
6N1P  
6N2P  
6N6P  
6N30P  
B719  
Cca  
CV2492  
CV2493  
CV5358  
E88CC  
E89CC,  
E188CC  
E189CC  
E288CC  
ECC85  
ECC88  
ECC89  
ECC188  
ECC189  
ECC288  
ECC289  
JAN 7308  
6GM8  
6N27P  
ECC86

### 12V TUBES:

5751  
5814  
5814A  
5963  
6189  
6201  
6681  
7025  
7058  
7729  
6L13  
12AD7  
12AT7  
12AU7  
12AX7  
12BH7(A)  
12DF7  
12DM7  
12DT7  
A2900  
B152  
B309  
B329  
B339  
B749  
CV0455  
CV0491  
CV0492  
CV4024  
E81CC  
E82CC  
E83CC

### 12V TUBES CONTINUED:

E181CC  
E183CC  
E283CC  
E811CC  
E812CC  
E813CC  
E2157  
E2163  
E2164  
ECC81  
ECC82  
ECC83  
ECC181  
ECC182  
ECC182  
ECC801  
ECC803  
ECC803S



- 300mA to 1000mA heater current draw tubes can be used
- 6V and 12V miniature 9 pin heater voltage tubes can be used

# *Project Ember*

Thank you for purchasing the Project Ember Headphone Amplifier Kit. This kit requires minimal electronics and soldering knowledge. The layout is easy to follow and setup is a snap! Please make sure to follow the instructions outlined in this guide and you will be enjoying your amp in no time. First, let's go over the tools and items required for your build which are as follows:

## **Required Assembly Tools:**

- Soldering iron, 25W minimum – Variable temp soldering station preferred with 1.5 – 2mm wide chisel tip
- .032 diameter 60/40 or 63/37 Tin/Lead solder is recommended. Lead free is difficult to work with and not recommended
- We specifically recommend Kester 331 water soluble flux solder, available on our website for purchase under (Parts – Buy)
- Magnifying glass (recommended but not required)
- Rubber Gloves (recommended but not required)
- 3M Green or Red Scotch Brite (recommended but not required)
- 3/32<sup>th</sup> Allen Key
- Flush cuts
- 90% Isopropyl alcohol (recommended but not required)
- Paper Towels (recommended but not required)
- Digital Multi Meter (DMM or DVOM)
- Heatgun or Hairdryer (for securing heatsinks)

## **Before You Start Soldering:**

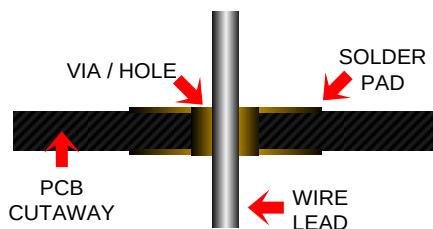
Prep work needs to be done. Wash your hands thoroughly and dry. Put on the recommended rubber gloves and scrub down the PCB (circuit board) on both the front and back side with 90% isopropyl alcohol to clean any residuals off of the board from manufacturing. Once the board has been cleaned, set it on a dry paper towel out of the way. Try to use the rubber gloves during the entire assembly process to keep oils off of the board and solder joints.

**Proper soldering is key to a quality final product. If you are new to soldering, here are some basic guidelines to follow. It would be wise to buy a copper project board and a few cheap resistors or other components to practice with before starting this project.**

## **Soldering and Solder Joints:**

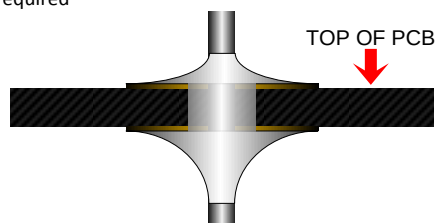
- For best results and maximum conductivity of any component, Wipe each wire lead down using Scotch Bright. Only one or two passes are required, making sure all of the surface has been cleaned. This removes oxidation or any other build up on the metal that has accumulated over time. Once cleaned, it is a good idea to further clean the wire leads with 90%+ isopropyl alcohol. Make sure all alcohol has evaporated prior to soldering as alcohol is VERY FLAMMABLE.
- Do not use too much or too little solder on each joint. See images below to get an idea of what you should be looking for
- The idea is to heat the pad and the component wire lead quickly and efficiently so that solder flows to each equally. Wetting the tip of your iron with a very small amount of solder will aid in quickly heating up the pad and wire lead.
- Having to heat a component for long periods of time, especially capacitors or LED's is NOT a good thing. When soldering capacitors or LED's, heat them only long enough to ensure a quality joint and let the unit cool down before soldering the second lead.
- The solder joint should look bright and metallic. A dull or dark gray looking joint is referred to as a "cold solder joint". Cold solder joints may not pose a problem initially, but can show up later in the amp's life.
- After every solder joint, make sure to clean the flux off your soldering iron tip with a wet sponge that should be provided with your soldering iron kit.

### **CUTAWAY OF A VIA AND SOLDER PAD PRIOR TO SOLDERING:**



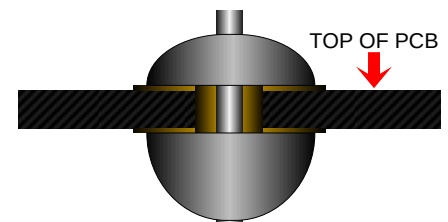
### **PROPER SOLDER JOINT:**

- Solder is bright and shiny. It is curved smoothly starting at the edge of the solder pad until it reaches the lead from the component
- Solder should fill the via and flow through the board slightly. It is ok to add solder to the top side of the board, however it is not required



### **IMPROPER SOLDER JOINT:**

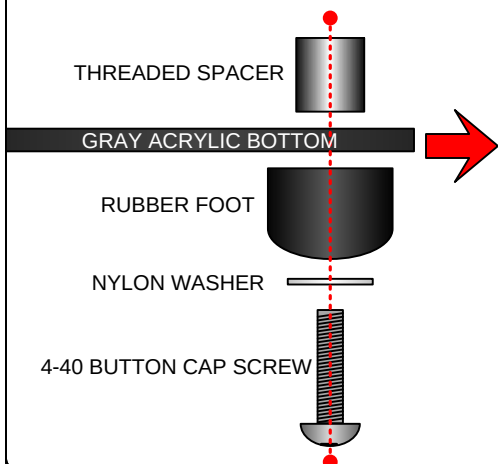
- A large blob of solder, often dull in color is not desired. The solder may not flow into the via hole and cause a poor connection or failure later in the amplifier's life.



# *Project Ember*

## Bottom Chassis Prep / Final Chassis Assembly:

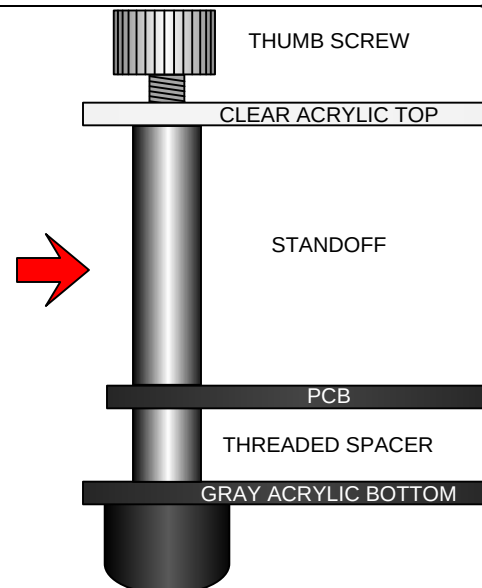
ASSEMBLE EACH OF THE 4 RUBBER FEET AS SHOWN, ATTACHING EACH FOOT TO THE GRAY SMOKED ACRYLIC BOTTOM CHASSIS



- ONCE THE PCB HAS BEEN ASSEMBLED, SET IT ONTO THE FOUR THREADS STICKING OUT OF THE BOTTOM GRAY ACRYLIC CHASSIS THAT YOU PREVIOUSLY ASSEMBLED.

- THREAD ON EACH OF THE FOUR HEX STANDOFFS ONTO THE THREADS THAT ARE NOW PROTRUDING THROUGH THE PCB, SECURING THE PCB TO THE GRAY ACRYLIC CHASSIS BOTTOM. PROCEED TO POWER ON THE UNIT (AS DESCRIBED ON PAGE 2, WEARING EYE PROTECTION AND AT A SAFE DISTANCE IN CASE OF A MISTAKE IN ASSEMBLY)

- ONCE THE AMPLIFIERS FUNCTIONALITY HAS BEEN TESTED AND THE UNIT HAS HAD A CHANCE TO FULLY WARM UP FOR 30 MINUTES, SET THE BIAS AS DESCRIBED LATER IN THIS MANUAL BEFORE PLACING THE TOP CLEAR ACRYLIC COVER IN PLACE



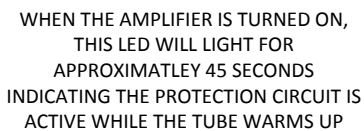
# *Project Ember*

## Project Ember Operation Guide:

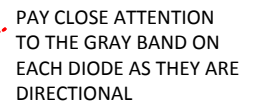
### Normal Operation and Notes:

- Plug in the amplifier and then the power supply (in that order). Make sure the tube, headphone jack and input RCA's are secure. Once the amplifier is turned to the ON position, the front red LED (closest to the volume knob and headphone jack) will illuminate red for approximately 30 seconds. This indicates the protection circuit is active while the tube is warming up. It may take several minutes for the tube to fully warm up depending on the tube type used
- When the protection circuit activates and de-activates, a slight click may occur
- Depending on the tube type chosen and the sensitivity of headphones used, background noise (hiss) may be present. Choosing a higher output impedance setting, or a lower gain tube can generally eliminate any background noise with sensitive headphones. This does not mean a high gain tube can not be used in our designs. Selecting a higher output resistance or lower input gain setting may reduce noise with higher gain tubes. We advise you experiment with several tubes to find out what you like best
- If load testing Project Ember, it is not recommended to attach a dummy load with a value below  $15\Omega$  when testing at full output power for a long periods. Heatsinks and the output devices at the bottom will become quite hot during testing. The amplifier will go into thermal protection when chip temperatures of  $150^{\circ}\text{C}$  are reached. Under normal conditions (playing music) even when driving low impedance loads, the output devices will get slightly warm at best.
- Some channel imbalance below 9 o'clock on the volume potentiometer is normal. We recommend you adjust your source output levels or the input attenuation module and use Project Ember with a volume setting of 9 o'clock or greater
- If input capacitors are bypassed, you will hear a scratching sound when adjusting the volume potentiometer
- Some faint scratch when turning the volpot is normal. This does not indicate a bad volpot – just a micro amount of DC that is present with certain tubes. This type of scratch is generally only heard with no music playing / rotating the volpot
- Cell phones or radio frequency devices in close proximity to Project Ember may create noise that is audible when listening to music (generally clicks or digital noises)
- Clean your Project Ember with a microfiber cloth and plastic cleaner (dusting with a microfiber cloth is generally all that is required). Compressed air is also great option for dust.
- Hot swapping tubes is not recommended (swapping tubes while the amplifier is on). Even though it does not cause technical errors or malfunctions it could damage headphones rated for 1W or less.

# Ember<sup>2.0</sup> Assembly Guide



**STEP 1: POPULATE ALL SMALL COMPONENTS ON THE BOARD SUCH AS RESISTORS, RIGHT ANGLE JUMPERS, DIODES AND SMALL CAPACITORS. THROUGHOUT YOUR BUILD, ALWAYS INSTALL THE SMALLER PARTS FIRST, WORKING YOUR WAY UP TO THE LARGER COMPONENTS**



LED MUST BE INSTALLED  
BEFORE SOLDERING THE  
TUBE SOCKET IN PLACE

PAY CLOSE ATTENTION TO THE BLACK BAND ON ALL DIODES OR ZENERS AS THEY ARE DIRECTIONAL

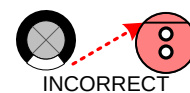
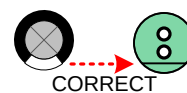
FLAT SPOT OR THE  
SHORT LEAD ON RED LED  
(INDICATES NEGATIVE  
SIDE OF LED) MUST FACE  
EXACTLY AS SHOWN

- RESISTORS AND INDUCTORS ARE NONPOLAR AND CAN BE FITTED IN EITHER DIRECTION. WHEN INSTALLING COMPONENTS, MAKE SURE THE COMPONENT VALUES ALWAYS FACE UP SO THEY ARE VISIBLE (CAN AID IN TROUBLESHOOTING IF A COMPONENT IS PLACED IMPROPERLY)
- DIODES, TRANSISTORS, IC'S AND ELECTROLYTIC CAPACITORS ARE POLAR AND PROPER ORIENTATION IS REQUIRED

# Project Ember

**STEP 2: POPULATE ALL MID SIZE COMPONENTS SUCH AS RCA'S, POWER COMPONENTS, SMALL CAPACITORS, TUBE SOCKET, RELAYS, TRIMMERS AND SO FORTH**

POLARIZED CAPACITORS MUST BE INSTALLED IN THE CORRECT DIRECTION (WILL HAVE A STRIPE DOWN THE SIDE DESIGNATING POLARITY) INSTALL THIS STRIPE FACING THE FLAT SPOT ON THE CAPACITOR OUTLINE ON THE BOARD



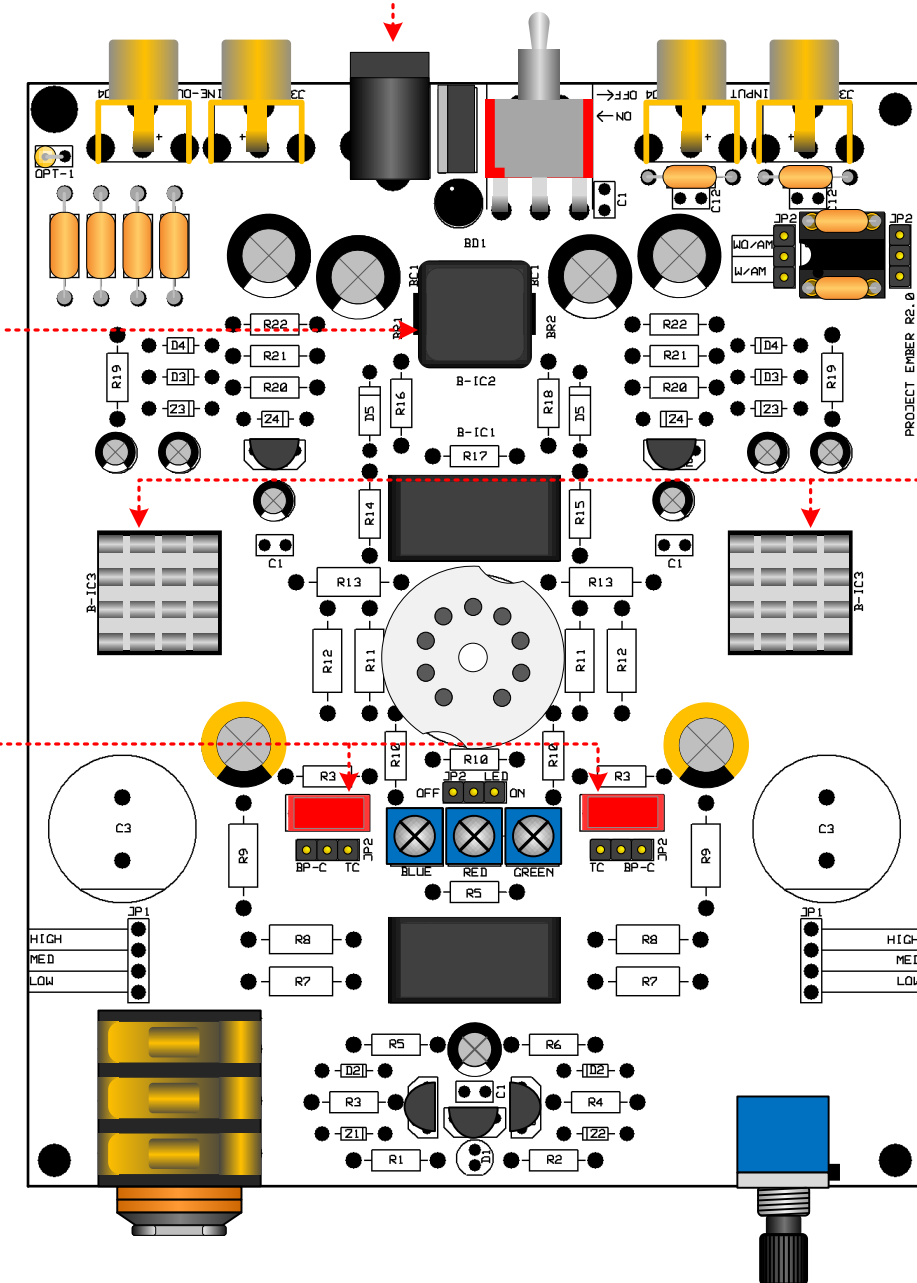
PLEASE NOTE: CENTER PIN OF DC SOCKET IS POSITIVE / 48VDC+

INSTALL SMD INDUCTOR PRIOR TO INSTALLING ALL OTHER PARTS IN THIS STEP. REFER TO PAGE 9 FOR SOLDERING GUIDE

INPUT CAPACITORS ARE NONPOLAR MEANING THEY HAVE NO STRIPE AND CAN BE INSTALLED IN EITHER DIRECTION

PEEL OFF THE PROTECTIVE ADHESIVE LAYER ON THE BOTTOM SIDE OF THE HEATSINK(S). PLACE THE HEATSINKS DIRECTLY OVER THE THERMAL PADS ON THE PCB. ONCE INSTALLED, USE A HAIR DRYER OR HEATGUN TO BRIEFLY HEAT UP EACH HEATSINK WHICH WILL ACTIVATE THE ADHESIVE.

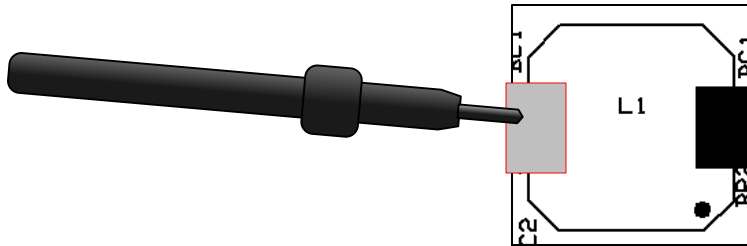
CAUTION: IF USING A HEATGUN, ONLY APPLY HEAT FOR A FEW SECONDS DIRECTLY ONTO EACH HEATSINK



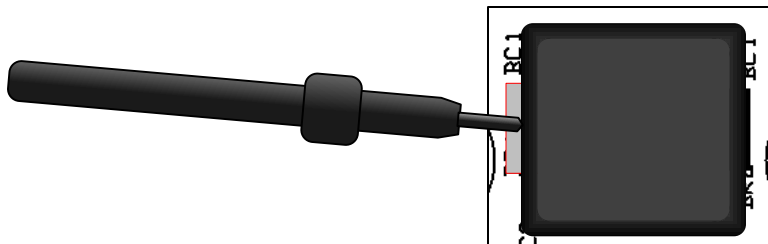
## INSTALLING THE SMD INDUCTOR

**INSTALLING AN SMD DEVICE IS ACTUALLY QUITE SIMPLE – HOWEVER MANY WORRY THAT IT IS DIFFICULT. ALL YOU NEED TO DO IS FOLLOW A FEW SIMPLE STEPS IN ORDER FOR THE INSTALLATION TO BE A SUCCESS.**

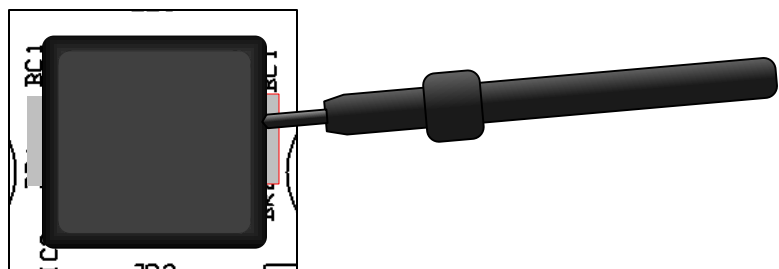
1. TIN ONE OF THE SOLDER PADS COMPLETELY SO SOLDER HAS FLOWED OVER THE ENTIRE PAD AS SHOWN. IT IS BEST TO POOL THE SOLDER SLIGHTLY SO THAT IT IS RAISED OFF THE PCB



2. PLACE THE INDUCTOR OVER THE TOP OF THE SILKSCREEN LAYOUT ON THE CIRCUIT BOARD SO THAT ONE SIDE / PAD OF THE INDUCTOR IS OVER THE SOLDER PAD YOU PREVIOUSLY HAVE TINNED. WHILE PRESSING DOWN ON THE INDUCTOR, HEAT THE SOLDER PAD THAT YOU PREVIOUSLY HAVE TINNED SO THAT SOLDER MELTS. YOU WILL FEEL THE INDUCTOR SLIGHTLY SINK INTO THE SOLDER. MAKE SURE THE INDUCTOR IS SQUARE ON THE PCB PRIOR TO REMOVING HEAT AND LETTING COOL.

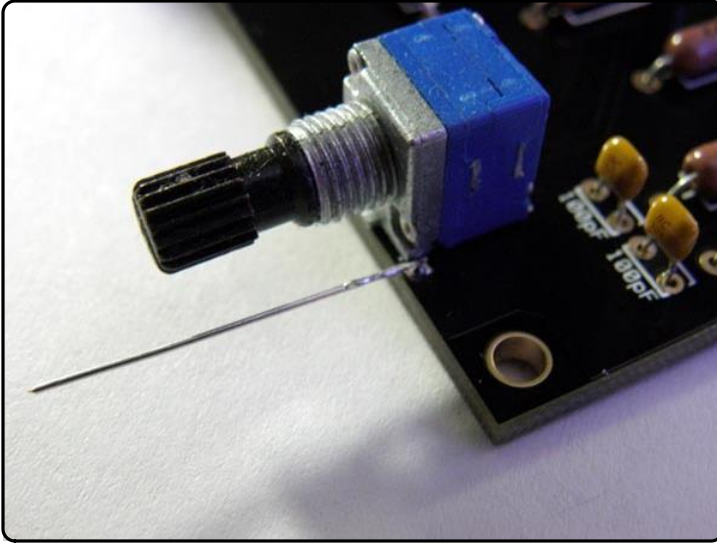


3. ONCE SOLDER HAS COOLED AND THE INDUCTOR IS SECURE, HEAT THE OTHER SOLDER PAD NEXT TO THE INDUCTOR AND ADD SOLDER SO THAT IT MELTS AND FLOWS / SOLDERING THE INDUCTOR TO THE PCB.



# *Project Ember*

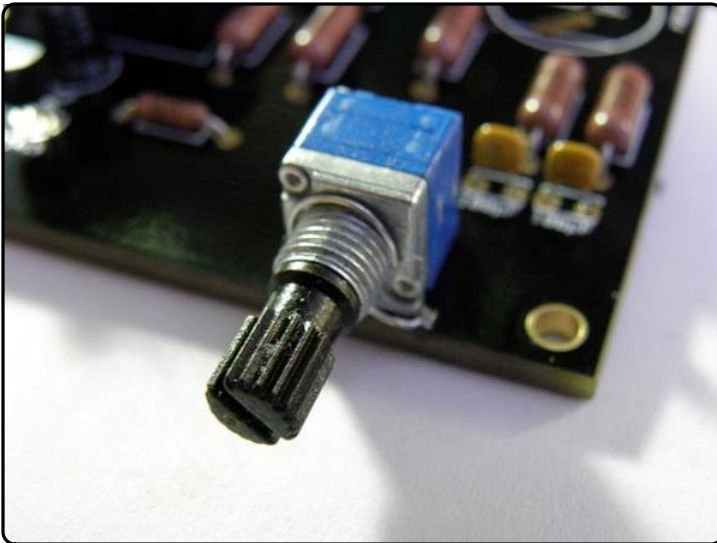
## VOLPOT GROUNDING



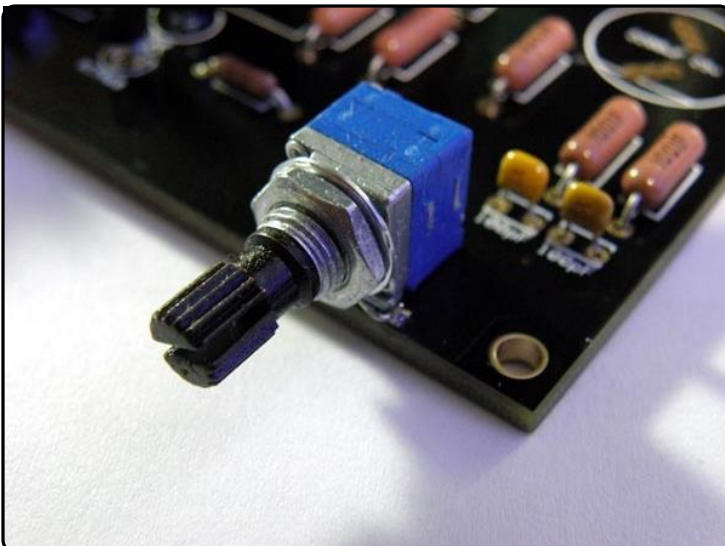
GROUNDING THE VOLUME POTENTIOMETER IS REQUIRED AS WITHOUT IT, THE AMPLIFIER MAY BE SUBJECTED TO NOISE / INTERFERENCE.

THE IMAGES ARE OF THE PREVIOUS GENERATION SUNRISE, HOWEVER THE GROUNDING PRINCIPAL IS EXACTLY THE SAME.

FIRST, INSERT A WIRE LEAD INTO THE RIGHT SIDE VIA NEXT TO THE VOPOT AND SOLDER IN PLACE.

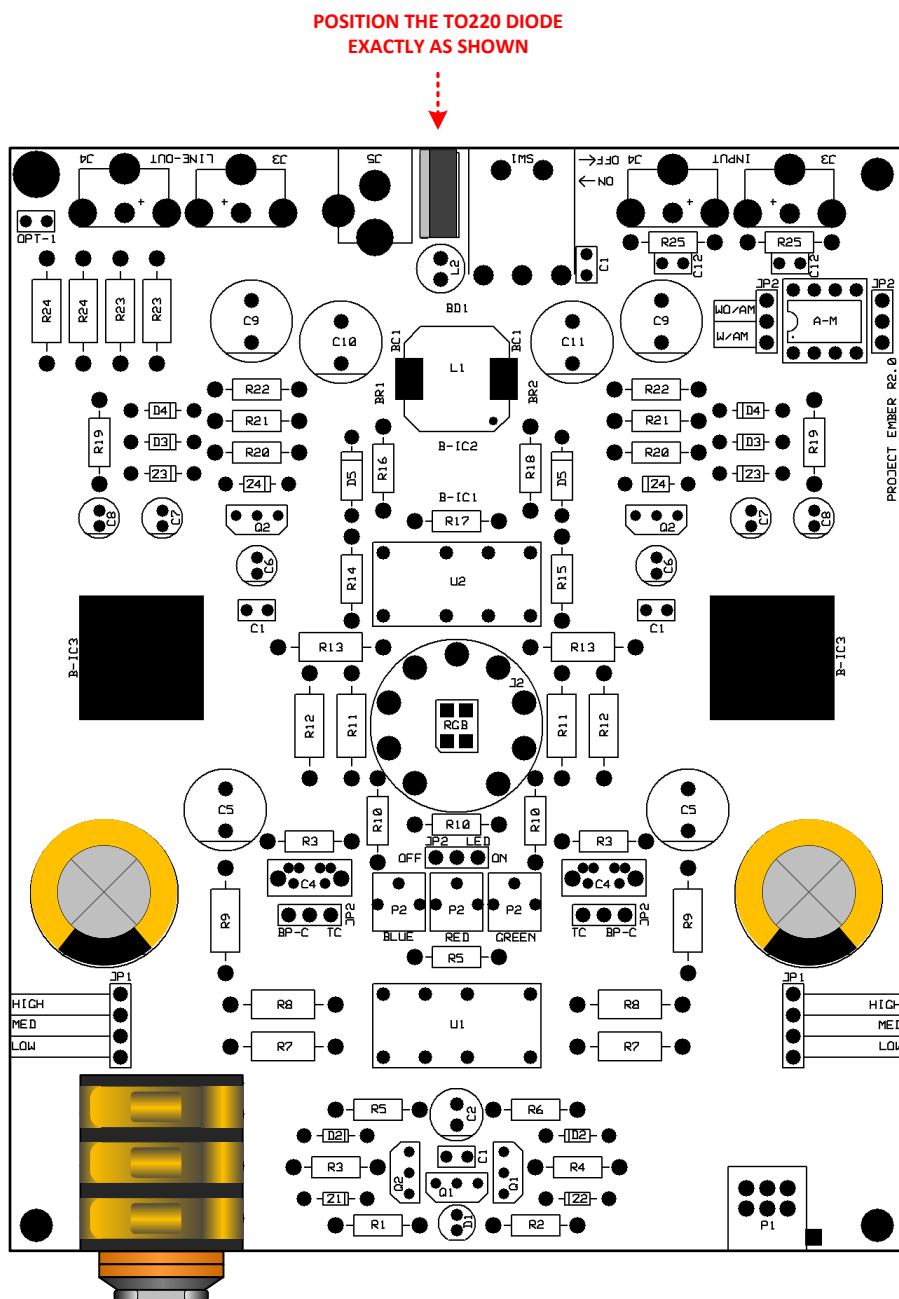


WRAP THE WIRE LEAD AROUND THE THREADED PORTION OF THE VOPOT AS SHOWN.



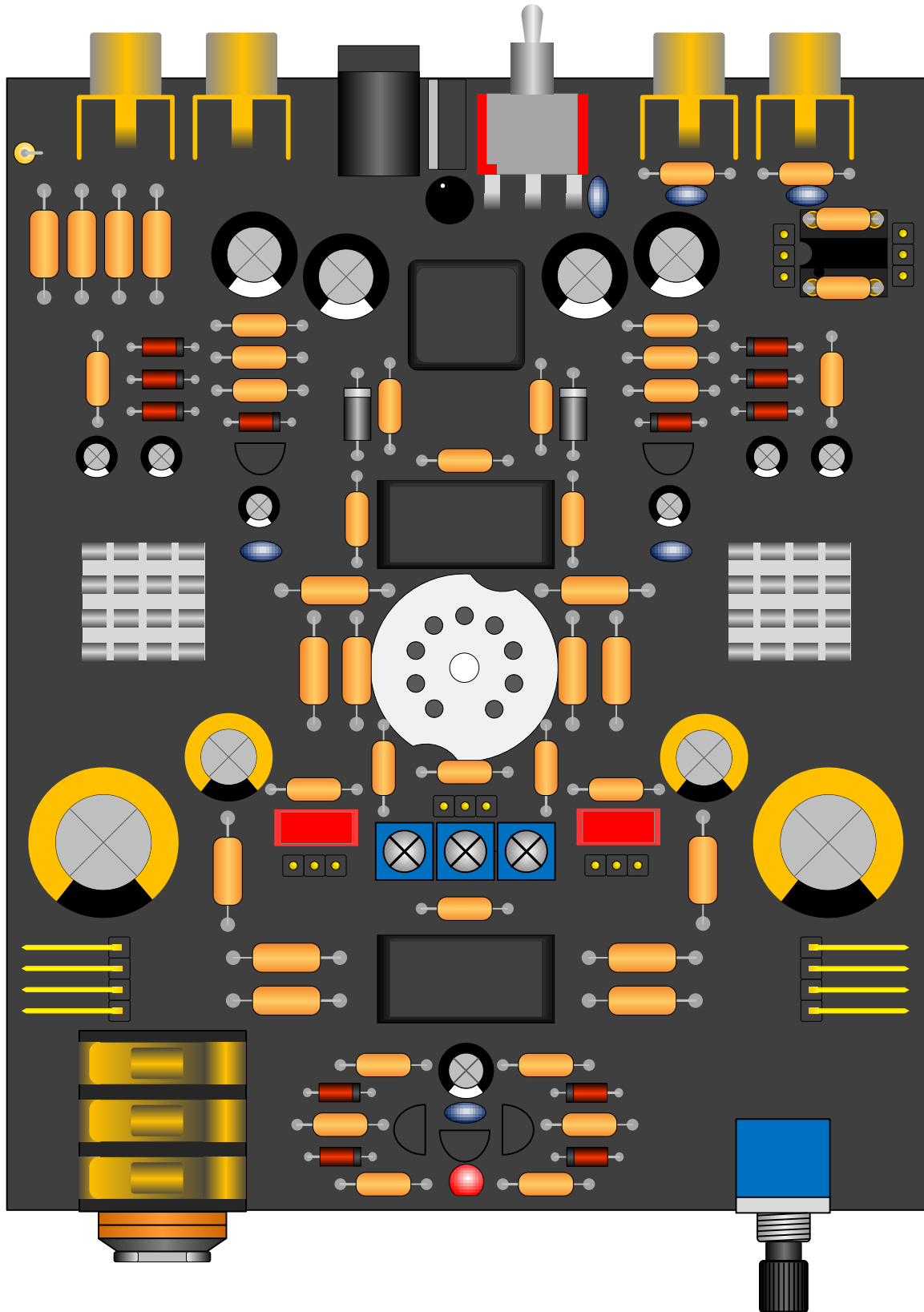
PUT ON WASHER AND NUT INCLUDED IN THE KIT. ONCE TIGHT, THE VOLUME KNOB MAY BE INSTALLED.

### STEP 3: POPULATE ALL LARGE SIZE COMPONENTS SUCH AS LARGE CAPACITORS, TO220 DIODE AND HEADPHONE JACK



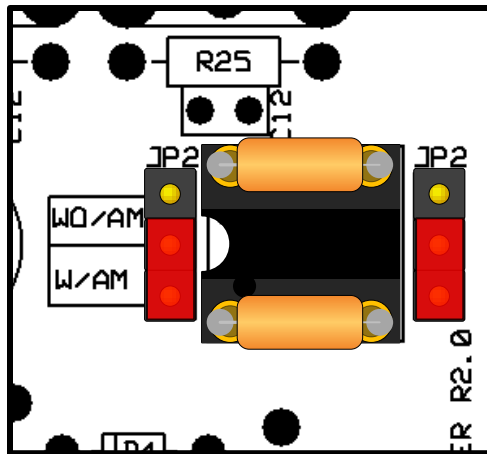
# *Project Ember*

COMPLETED EMBER LAYOUT



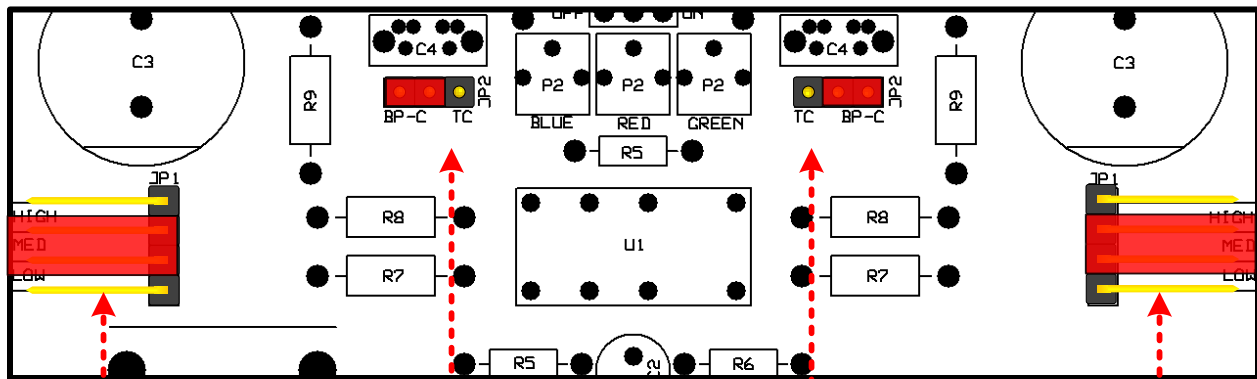
# Project Ember

Project Ember has several jumpers settings to customize the amp the way you would like it. Below gives you the details on what these jumper settings do!



INPUT ATTENUATION CAN BE CHANGED VIA THE WO/AM (WITHOUT MODULE) AND W/AM (WITH MODULE)

JUMPER TABS AT THE BACK, RIGHT HAND CORNER OF THE AMPLIFIER. DEFAULT SETTING IS LOW GAIN OR W/AM

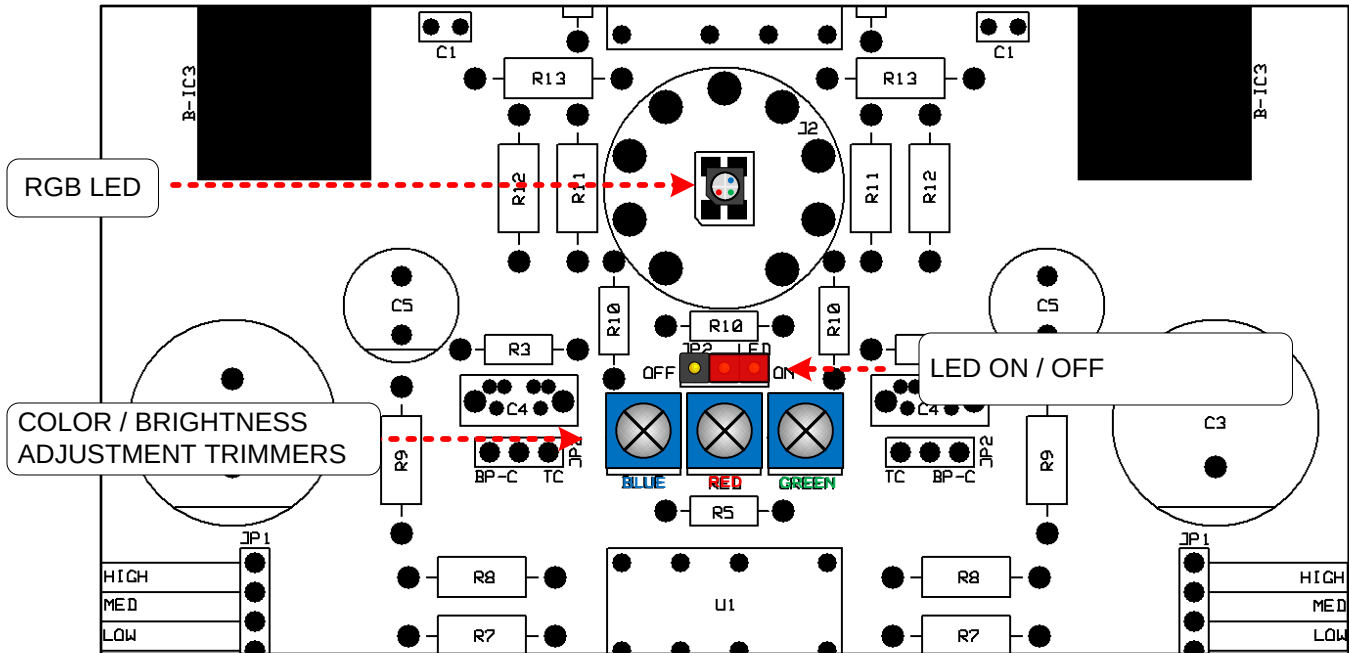


INPUT CAPACITORS CAN BE BYPASSED PER YOUR PREFERENCE. MANY VIEW THIS AS A PURIST FUNCTION AS IT IS ONE LESS COMPONENT IN THE SIGNAL PATH. WITH INPUT CAPS BYPASSED, YOU MAY HEAR A SCRATCHY SOUND WHEN ADJUSTING VOLUME. THIS WILL NOT DAMAGE YOUR HEADPHONES OR YOUR AMPLIFIER  
**TC = SIGNAL GOES THROUGH CAP (EXAMPLE SETTING IN RED)**  
**BP-C = SIGNAL DOES NOT GO THROUGH INPUT CAP (BYPASSED)**

OUTPUT RESISTANCE IS CONFIGURABLE BETWEEN 0.1Ω (LOW) 35Ω (MID) AND 120Ω (HIGH). HIGHER OUTPUT RESISTANCE CAN HAVE AN EFFECT ON BASS AND/OR TREBLE FREQUENCIES. THIS EFFECT IS DEPENDANT ON THE HEADPHONE IMPEDANCE. (EXAMPLE OF 35Ω SETTING IN RED) EXPERIMENT BY CHANGING THE SETTINGS TO FIND WHAT YOUR PREFERENCE IS

# Project Ember

## LED Light Color



Another feature of Project Ember is an adjustable RGB (RED GREEN BLUE) LED under the tube. RGB LED's can produce almost any color desirable. We understand this is not an audiophile feature or a feature that has anything to do with the sound of the amplifier. Each of us has a favorite color that is enjoyable to look at. Using the three trimmers located above, you can dial in any color you desire and also the brightness of that color. Often manufacturers tie you into their specific color scheme on their products. We feel it is important for you to choose the color you desire which can set an enjoyable mood when listening to your music. Adjust the brightness and color by turning each of the trimmers with a small jewelers screwdriver. Or simply disable the RGB LED (jumper) enjoy the glow of the tube.

# *Project Ember 2.0*

## **Resistors**

R1 = SM 100K X 1  
R2 = SM 470K X 1  
R3 = SM 10K X 3  
R4 = SM 330K X 1  
R5 = SM 330R X 2  
R6 = SM 4K7 X 1  
R7 = LG 120R X 2  
R8 = LG 47R X 2  
R9 = LG 2.2K X 2  
R10 = SM 220R X 3  
R11 = LG 100K X 2  
R12 = LG 1K X 2  
R13 = LG 1K X 2  
R14 = SM 1K X 1  
R15 = SM 39K X 1  
R16 = SM 10K X 1  
R17 = SM 18R X 1  
R18 = SM 1K X 1  
R19 = SM 39K X 2  
R20 = SM 39K X 2  
R21 = SM 18K X 2  
R22 = SM 1K8 X 2  
R23 = LG 220R X 2  
R24 = LG 1K X 2  
R25 = SM 1K X 2

## **Diodes**

Z1 = BZX79-C43 X 1  
Z2 = BZX79-C39 X 1  
Z3 = BZX79-C10 X 2  
Z4 = BZX79-C22 X 2  
D1 = RED LED X 1  
D2 = 1N4148 X 2  
D3 = 1N4148 X 2  
D4 = 1N4148 X 2  
RGB = RGB LED X 1  
D5 = SB140 X 2  
D6 = TO-220 DIODE

## **Regulators**

IC1 = OPA551 X 2  
IC2 = TS921 X 1

## **Bottom of PCB**

B-IC1 = TS921 X 1  
B-IC2 = LM2576 X 1  
B-IC3 = OPA551 X 2  
BR1 = 4.53K X 1  
BR2 = 1K X 1  
BC1 = 100nF X 2

## **Jacks**

J1 = HEADPHONE JACK X 1  
J2 = TUBE SOCKET X 1  
J3 = BLACK RCA JACK X 2  
J4 = RED RCA JACK X 2  
J5 = POWER INPUT JACK X 1

## **Capacitors**

C1 = 100nF X 4  
C2 = 47uF 63V X 1  
C3 = 2200uF 63V X 2  
C4 = 1uF X 2  
C5 = 470uF 10V X 2  
C6 = 10uF 63V X 2  
C7 = 10uF 63V X 2  
C8 = 100uF 16V X 2  
C9 = 47uF 100V X 2  
C10 = 100uF 63V X 1  
C11 = 1000uF 16V X 1  
C12 = 100pF X 2

## **Transistors**

Q1 = BC546 X 2  
Q2 = BC556 X 3

## **Inductor**

L1 = 330uH SMD X 1  
L2 = 100uH X 1

## **Jumpers**

JP1 = 4 PIN RA X 2  
JP2 = 3 PIN STRAIGHT X 5

## **Switches**

SW1 = POWER SWITCH X 1

## **Potentiometers / Trimmers**

P1 = 10K VOLUME POTENTIOMETER X 1  
P2 = 50K SINGLE TURN TRIMMER X 3

## **Relay**

U1 = 48V RELAY X 1  
U2 = 5V HIGH SENSITIVITY RELAY X 1

## **Other**

HEATSINK X 2  
JUMPER TABS X 7  
ATTENUATION MODULE X 1